A Systematic Approach for Increasing Pneumococcal Vaccination Rates at an Inner-City Public Hospital

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Background: While the Advisory Committee on Immunization Practices recommends a standing order as the most effective mechanism to increase pneumococcal and influenza vaccination rates, Georgia's Medical Practice Act does not authorize nurses to screen, order, and administer adult vaccines in inpatient settings.

Methods: The setting was a 1000-bed public teaching hospital in metropolitan Atlanta. A 1-month intervention (INT1) included four wards randomized to intervention or control. A 5-month hospital-wide intervention (INT2) followed INT1. The intervention used was provider reminder with in-service training. Chart review was the measure used. The main outcome was pneumococcal vaccination prior to discharge.

Results: During INT1, 534 patients (296 intervention and 238 control) were discharged. Of the 534 patients, 475 (89.0%) were African American, 188 (35.2%) were uninsured, and the median age was 48 (range 19 to 96). Of the 205 intervention patients with vaccine indications and no contraindications, 78 of 205 (38%) were vaccinated compared to 7 of 143 (4.9%) of the control patients ($p<0.001$). During INT2, 879 patient charts were reviewed. Patient demographics were similar to INT1. However, of 554 eligible patients, 16% were vaccinated, significantly higher than control floors during INT1 ($p<0.001$). Although nurses initiated the form almost 70% of the time, physicians assessed fewer than 35% of patients with indications.

Conclusions: Significantly higher proportions of high-risk patients were vaccinated through the use of a preprinted nurse screening and physician order form. However, a significant percentage of patients did not receive the vaccine owing to the physician's failure to order it. In these cases, use of standing orders would have further increased vaccination rates while also promoting a more sustainable program.

Medical Subject Headings (MeSH): adult, delivery of health care, guideline adherence, hospital, hospital communication systems, immunization, medication systems, pneumococcal vaccines, reminder systems (Am J Prev Med 2002;22(2):92–97)

Introduction

In the United States, *Streptococcus pneumoniae* is a significant cause of morbidity and mortality.[1] Pneumococcal disease is responsible for approximately 50,000 cases of bacteremia and 3000 cases of meningitis, and the national annual incidence rate of invasive pneumococcal disease is estimated at 15 to 30 cases per 100,000 people.[2] The emergence and growth of antibiotic drug resistance compound the difficulty in treating *S. pneumoniae*. Nationwide, approximately 44% of the respiratory pneumococcal isolates were resistant to penicillin,[3] and costs associated with treatment of microbial-resistant *S. pneumoniae* have escalated to over $4 billion annually.[4]

An efficacious and cost-efficient vaccine—23-valent pneumococcal polysaccharide—has been available since 1983, but it is widely underused. The national vaccination rate for adults aged ≥65 years was 54.1% in 1999 (49.7% in Georgia), yet the rate differed significantly by race/ethnicity at 56.8% for whites, 34.6% for Hispanics, and 36.4% for blacks.[5] More alarming is that patients aged <65 with chronic health conditions have even lower vaccination rates.

Many studies have shown increases in adult vaccination through the use of a physician standing order.[6–11] In addition, the Advisory Committee on Immunization

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Practices (ACIP) and the U.S. Task Force on Community Preventive Services strongly recommend the use of standing orders as one of the most effective mechanisms to increase pneumococcal and influenza vaccination rates.[12–14] Standing orders as a single-component intervention have been associated with a median 51% increase in vaccination coverage.[14] Provider reminders are also recommended as effective strategies for improving rates with a median 17% increase in vaccination coverage when used alone.[14] We have not been able to employ a standing order in our institution because Georgia's Medical Practice Act, as interpreted by our facility's legal department, does not authorize registered nurses to order and administer medications, including immunizations, without a physician's assessment in the inpatient hospital setting. Thus, we designed and evaluated the effectiveness of a nurse-initiated, provider-reminder system as a substitute for standing orders.

Methods

Grady Memorial Hospital is a 1000-bed public hospital serving primarily an indigent, African-American population in Atlanta, Georgia, and is staffed by residents in training from two local residency programs. We evaluated the effectiveness of a provider-reminder system initiated by nurses on pneumococcal vaccination rates in our inpatient areas. The reminder system used a preprinted screening and order form. Vaccination rates were evaluated during two phases: a 1-month period in which four wards were randomized to the intervention or control (INT1) group, and a 5-month period in which the intervention was implemented hospital-wide (INT2).

INT1 compared vaccination rates among patients discharged from two intervention floors to patients discharged from two control floors for 4 weeks in May and June 1999. All four floors were adult medicine wards. Intervention area nurses, physicians, and administrators received both in-service education prior to commencing the pilot study, and then received continual feedback regarding the form's use and vaccination rates. Two cycles of physicians rotated through the areas, and they were in-serviced upon commencement. The preprinted forms were included in patients' admission packets and placed in the physician-order section of the chart. Nurses assessed patients for vaccine candidacy upon admission and flagged the form for physicians if the patient had indications. Physicians ordered the vaccine for eligible patients (i.e., those with indications and no contraindications) after obtaining the patient's verbal consent. No education or organizational changes were provided for the control floors. Chart reviews to determine underlying disease, vaccination history, and vaccination during the current hospital visit were conducted during discharge for all patients from both the intervention and control floors. Patients were considered previously vaccinated if the completed provider-reminder form indicated that the patient reported prior vaccination or if we found documentation of prior vaccination in the chart review.

After INT1 was completed, modifications were made to the preprinted form, including the addition of the influenza vaccine. The hospital-wide intervention, INT2, began on February 1, 2000, and surveillance was conducted for 5 months. Rather than targeting only two hospital areas, this intervention targeted all inpatient areas of the hospital with no control group, including both critical care and psychiatric units. Study personnel routinely conducted chart reviews for all patients discharged during a specified 1-week period during each surveillance month. A broad range of in-services were provided for nursing, administration, and physician staffs prior to initiating the intervention, and feedback was provided to hospital staff throughout the surveillance period. New cycles of physicians began at the start of each month and were in-serviced upon commencement. Chart reviews were conducted at discharge for patients in non–critical care areas. Since critical care patients were rarely discharged directly from their units, they were not included in this analysis. Emory University's Internal Review Board approved the project study design.

Categorical comparisons between study groups were carried out using Mantel–Haenszel χ^2 tests, while t-tests were used to evaluate continuous variables. Logistic regression modeling techniques to determine p values were performed using SAS 6.12 (Cary, North Carolina). Logistic regression techniques used methods outlined by Kleinbaum,[15] where demographic variables remained in the final model. Collinearity and interactions were analyzed and found to be nonsignificant.

Results

INT1 Results

During the 4-week INT1 study period, 534 patients were discharged from four inpatient areas, 296 patients from two intervention floors, and 238 from two control floors. Intervention and control groups were similar with regard to race/ethnicity, gender, age, and insurance status (Table 1). Overall the population was African American (89.0%), female (51.7%), and middle aged (median age 48), and more than one third were uninsured (35.2%). However, there were differences between the groups regarding the presence of vaccine indications. Eighty-three percent of intervention patients had vaccine indications, compared to only 72% of control patients ($p<0.01$). Although the most common indications were diabetes (28%), alcohol abuse (26%), age ≥65 years (26%), and pulmonary disease (20%), there were statistically more patients classified as alcoholics in the control group (33.3% vs 21.1%, $p<0.01$). Only 16% of high-risk patients (i.e., those with indications) were previously vaccinated.

On the intervention floors, almost 70% of patients were eligible for vaccination, compared to 63% on the control floors ($p=0.13$) (Table 2). Nurses screened 55% of patients with indications, and 47% were assessed by their physicians before discharge. The overall vaccination rate among eligible patients (i.e., those with indications and no contraindications) on the intervention floors was 38%, compared to the vaccination rate of 5% on the control floors. Patients dis-

Table 1. Patient demographics during INT1 (1-month intervention or control in four wards) and INT2 (5-month hospital-wide intervention)

Demographic	INT1 Intervention (n=296)	INT1 Control (n=238)	p	Hospital-wide intervention, INT2 Month 2 (n=303)	Month 3 (n=293)	Month 5 (n=283)	p
Race							
Black	265 (89.5%)	210 (88.2%)		252 (83.2%)	242 (82.6%)	237 (83.7%)	
White	25 (8.4%)	17 (7.1%)	0.21	33 (10.9%)	30 (10.2%)	27 (9.5%)	0.47
Other	6 (2.0%)	11 (4.6%)		18 (5.9%)	21 (7.2%)	19 (6.7%)	
Gender							
Male	142 (48.0%)	116 (48.7%)	0.86	173 (57.1%)	169 (57.7%)	175 (61.8%)	0.45
Median age (range)	48 (19, 96)	47 (19, 95)		47 (18, 99)	46 (16, 101)	46 (17, 95)	
Indications							
Yes	247 (83.4%)	171 (71.8%)	0.001	218 (71.9%)	210 (71.7%)	201 (71.0%)	0.97
Common indications	(n = 247)	(n = 171)		(n = 218)	(n = 210)	(n = 201)	
Diabetes	69 (27.9%)	48 (28.1%)	0.98	68 (31.2%)	62 (29.5%)	53 (26.4%)	0.55
Alcohol abuse	52 (21.1%)	57 (33.3%)	<0.01	38 (17.4%)	53 (25.2%)	48 (23.9%)	0.11
Age ≥65	58 (23.5%)	49 (28.7%)	0.23	57 (26.1%)	48 (22.4%)	48 (23.9%)	0.72
Lung disease	48 (19.4%)	35 (20.5%)	0.79	46 (21.1%)	37 (17.6%)	34 (16.9%)	0.49
Heart disease	53 (21.5%)	26 (15.2%)	0.11	52 (23.9%)	38 (18.1%)	39 (19.4%)	0.30
HIV	33 (13.4%)	21 (12.3%)	0.75	40 (18.3%)	41 (19.5%)	51 (25.4%)	0.17
Chronic renal failure	24 (9.7%)	8 (4.7%)	0.06	24 (11.0%)	12 (5.7%)	11 (5.5%)	0.05
Previous vaccination							
Yes	41 (16.6%)	28 (16.4%)	0.95	27 (12.4%)	26 (12.4%)	20 (10.0%)	0.67

INT1, Intervention 1; INT2, Intervention 2.

charged from intervention areas were 7.8 times more likely to receive the pneumococcal vaccine than patients discharged from control areas (95% CI, 3.70–16.34; p<0.001).

Multivariate analysis controlling for patients' race/ethnicity, gender, age, insurance status, and vaccine indications demonstrated that the intervention group was 11.7 times more likely to be vaccinated than the control group (95% CI, 5.07–27.22; p<0.001). When using a model to determine other variables that influenced vaccination among eligible patients, diabetes (odds ratio [OR]=0.48, p=0.04) or chronic renal failure (OR=0.15, p=0.02) decreased the likelihood of vaccination during admission.

Table 2. Vaccination evaluation during INT1 (1-month intervention and control in four wards) and INT2 (5-month hospital-wide intervention)

Evaluation	INT1 Intervention	INT1 Control	p^a	Hospital-wide intervention, INT2 Month 2	Month 3	Month 5	p^b
Total patients reviewed[c]	296	238		303	293	283	
Patients with indications	247 (83.4%)	171 (71.8%)	<0.01	218 (71.9%)	210 (71.7%)	201 (71.0%)	0.97
Patients previously vaccinated/ contraindications	42 (17.0%)	28 (16.4%)	0.87	27 (12.4%)	26 (12.4%)	22 (10.9%)	0.99
Eligible patients[d]	205 (69.3%)	150 (63.0%)	0.13	191 (63.0%)	184 (62.8%)	179 (63.3%)	0.99
Patients with form in chart (out of total patients)	206 (69.6%)	0 (0.0%)	—	242 (79.9%)	227 (77.5%)	217 (76.7%)	0.62
Patients with indications, screened by nurses	142 (57.5%)	0 (0.0%)	—	148 (67.9%)	134 (63.8%)	115 (57.2%)	0.07
Patients with indications, assessed by physicians	115 (46.6%)	Unknown	—	62 (28.4%)	73 (34.8%)	36 (17.9%)	<0.01
Patient refusals (out of eligible patients)	1 (0.5%)	Unknown	—	4 (2.1%)	4 (2.2%)	0 (0.0%)	0.14
Vaccination rate (out of eligible patients)	78 (38.0%)	7 (4.7%)	<0.001	29 (15.2%)	39 (21.2%)	18 (10.1%)	0.01

[a] p values refer to comparisons between pilot and control groups.
[b] p values refer to comparisons among all three INT2 groups.
[c] During INT1, all patient charts were reviewed; during INT2, approximately 9% of all discharges were reviewed.
[d] Patients with indication are those without contraindications or history of vaccination.
INT1, Intervention 1; INT2, Intervention 2.

INT2 Results

During INT2, 9813 patients were discharged from adult patient care areas, and 879 (9.0%) of these patients' charts were reviewed (during a selected week each month as described in the Methods section). The overall demographics among this population were similar to the INT1 population regarding race/ethnicity, insurance, and median age. However, more of the charts reviewed were those of male patients during INT2 than during INT1 (Table 1). As this intervention involved all inpatient areas, including psychiatric and surgical floors, fewer patients had vaccine indications (70%), compared to INT1 (83%, $p<0.001$). Only 63% of the patients discharged were eligible for vaccination versus 70% of the eligible patients on the intervention areas during INT1 ($p=0.05$). Moreover, almost half of all patients did not attend one of our primary care clinics.

Throughout the hospital-wide intervention (INT2), nurses consistently initiated the reminder system for patients with indications (Table 2). However, physicians assessed fewer than 35% of patients with indications. The overall vaccination rate among eligible patients reached an average of 16% over the 5-month surveillance period, significantly less than the 38% vaccination rate during INT1 ($p<0.001$). Still, this rate was substantially higher (95% CI, 1.5–6.7) than the vaccination rates on the control floors during INT1 (16% vs 4.7%, $p<0.01$). In addition, in both INT1 and INT2 there were very few patient refusals—less than 2.5% during all time periods. Importantly, of the patients whose nurse had initiated the system and determined that the patient was a potential candidate for vaccination, over half (226 of 397, 56.9%) received care from a physician who failed to consider vaccination before discharge, creating an unnecessary missed opportunity.

Univariate analysis demonstrated that patients with a form present in the chart were more likely to be vaccinated (OR=20.6, $p<0.001$) and that diabetics were less likely to receive the pneumococcal vaccine (OR=0.58, $p=0.03$). Multivariate analysis indicated that positive risk factors for vaccination included having a form in the chart (OR=28.6, $p<0.001$) and being treated by a nonsurgical physician team (OR=2.24, $p=0.047$), while having diabetes (OR=0.56, $p=0.049$) negatively impacted vaccination rates when controlling for race/ethnicity, sex, insurance status, and specific vaccine indications.

Discussion

Our nurse-initiated, provider-reminder system was successful in improving vaccination rates with seven-fold and three-fold increases over control areas during the INT1 and INT2 phases, respectively. These results met or surpassed other reminder systems[6,16–19] and even some standing order programs.[6] Organizational strategies utilizing reminder systems in states that do not authorize standing orders can be successful at improving vaccination rates.

The provider-reminder system was also successful at keeping patient refusal to a minimum, with <3% of patients refusing vaccination after it was offered by their physician. Patient refusals were higher in other studies in which standing orders were utilized.[6–9,11] The reason for our low refusal rates was most likely the physician's involvement in offering immunizations. Many recent studies[20–23] have demonstrated a strong correlation between provider immunization recommendations and increased patient vaccinations. Nichol et al.,[21] for example, found that provider recommendation was strongly associated with increased influenza and pneumococcal vaccinations, regardless of the patients' positive or negative immunization attitudes. An additional benefit of keeping physicians—and specifically those in residency training programs—involved in the immunization process is to assist with the formation of good long-term practice habits.

Still, physicians' lack of compliance directly contributed to the lower vaccination rates during the hospital-wide intervention (INT2). In this teaching facility, nurses were the consistent presence on the floors, while the physician staff had a high turnover rate, with new residents and faculty rotating in each month. This regular turnover created a low institutional memory among physicians and hindered the success of the provider-reminder system. In addition, preventive services—and more specifically immunization programs—conducted in the hospital setting are a low priority for physicians, thus strengthening the argument for the use of standing orders, especially in facilities where physician turnover is high. In contrast, when patients had indications, nurses initiated the system almost 70% of the time. If standing orders were hypothetically implemented in this system, it may have resulted in higher vaccination rates, assuming that nurses would operate equally well with a standing-orders program.

In examining published success rates for standing-order programs, we found that INT1 reached a comparable vaccination rate to a standing-order program conducted at two small community hospitals in Minnesota.[6] These two hospitals had an average of 29 beds each and reached a vaccination rate of 40%, comparable to the pilot study vaccination rates of 38% in our 60-bed area. In another standing-order program conducted at a 400-bed New York teaching hospital, vaccination rates reached 78% with the use of a "shot nurse."[7] This program may have faced long-term sustainability issues, especially in times of nursing shortages, where the designated shot nurse may be pulled away from these duties to assist with other patient care functions. Furthermore, in a large teaching hospital such as our facility, a designated shot nurse may not be able to reach all patients before they are discharged.

Inner-city urban hospitals are ideal locations for such immunization projects because many patients are at higher risk for contracting invasive pneumococcal disease and have never been vaccinated. An intervention such as the one described here can save lives and be cost saving even with a 15% vaccination rate. We estimate that in 2 years approximately 48,000 adults are discharged from the Grady Health System (GHS) in Atlanta, Georgia; 33,860 (70%) have vaccine indications, and 32,844 (85%) of these have never been vaccinated. On average, 15% of adults with indications are HIV infected. We calculated the difference in hospital charges and invasive pneumococcal disease incidence and mortality over a 2-year period among this population with the use of a provider reminder that results in a discharge vaccination rate of 15%, compared to a baseline discharge vaccination rate of 3%. We made the following conservative assumptions: (1) annual invasive pneumococcal disease incidence of 100 per 100,000 of HIV-negative adults with indications (Georgia Emerging Infections Program, Atlanta, Georgia, unpublished data, 1999) and 800 per 100,000 HIV-positive adults[24]; (2) invasive pneumococcal disease mortality rate of 15% for both HIV- and non–HIV-infected patients (Georgia Emerging Infections Program, Atlanta, Georgia, unpublished data, 1999); (3) vaccine efficacy of 70% in non–HIV-infected and 0% in HIV-infected (HIV-infected patients admitted to our hospital have a median CD4 count of <75); (4) pharmacy and administration charges of $17.20 per dose; and (5) an average of $13,000 in hospital charges per admission with invasive pneumococcal disease (GHS Information Services, unpublished data, 1999). No additional healthcare worker costs were considered as adult vaccination represents an activity that should be part of usual practice in this setting. Using these assumptions over a 2-year period, the provider-reminder system would result in savings of $924,838 in hospital charges, 76 fewer cases of invasive disease, and 11 fewer deaths. These findings are significant because most cost-effective prevention programs are not usually cost saving. Sisk et al.[25] state that "policymakers generally consider costs of up to $50,000 or even $100,000 to be worth an extra year of healthy life." GHS and similar institutions should consider this type of project an opportunity to save money and lives.

Obstacles to receiving the pneumococcal vaccine include lack of form placement in the chart by the clerical staff and availability of the vaccine on the floor. Since having the form in the chart was associated with improved rates, further efforts should be made to improve the clerical staff's placement of the form. In our hospital, the protocols and policies developed were advocated by the nursing administration. However, floor staff implemented the policy and gaining their support was a more challenging task. This was further complicated by the facts that form placement and vaccination rates decreased by the fifth month of surveillance. This observations makes the long-term sustainability of the program questionable. However, vaccination rates of 10% to 15% per year can still be considered a cost-effective alternative to no intervention. The issue surrounding vaccine availability was that vaccines were stored in the pharmacy department and sent to floors when orders were made rather than being stocked on the floors. In a few cases, physicians had ordered the vaccine for their patients, but because the vaccine had to be sent up from the pharmacy, the patients left before being vaccinated.

In addition to having a form in the chart, we found that a nonsurgical physician team predicted appropriate use of the provider-reminder form and pneumococcal vaccination prior to discharge. As the importance of adult vaccination is not emphasized in surgical house–officer training, this is not surprising. It was surprising that patients with diabetes (overall the most common vaccine indication in our patients) were less likely to be appropriately vaccinated than nondiabetics, and we are not able to offer a specific explanation for this finding. Undervaccination of diabetics is a problem nationally; black diabetics have a 20% prevalence of pneumococcal vaccination.[26] Many patients and providers are not aware that diabetes is an indication for both pneumococcal and influenza vaccines.

Additional factors may have influenced the decrease in vaccination rates during the hospital-wide intervention. For example, during INT1 education was provided for each physician team assigned to the intervention floors, while during INT2 all physician services were educated at a brief meeting rather than at the physician team level. Furthermore, during INT1 floors were monitored for 4 weeks, while during INT2 floors were monitored for only 1 week during each month. The surveillance staff was not present on a daily basis during INT2, and their day-to-day presence during INT1 may have heightened both nurse awareness and physician awareness, thereby affecting vaccination rates.

Inpatient vaccine programs at urban inner-city hospitals should be considered a standard of care and should continue to be pursued as efforts are made to reach *Healthy People 2010* objectives.[27] In a recent article, Dexter et al.[28] describe a successful computerized reminder system for patients hospitalized in an urban, public teaching hospital. This program was made possible by the presence of computer order entry, automatic "screening" for vaccine indications by the computer, and the fact that physicians could respond to the prominent reminder with a single keystroke. Improved hospital information systems, such as those used by Dexter et al.,[28] will eliminate problems such as the absence of a form in the chart and will be the key to sustaining success with provider-reminder interventions. It is possible that vaccine intervention programs may not be as effective in community hospitals where the prevalence of vaccine indications may be lower and patients may have had more vaccinations. Organizing reminder programs or standing-order systems in outpatient settings should be pursued, especially in areas serving minority populations, but inpatient interventions can serve to reach the patients at highest risk.

States such as Minnesota and New York have standing orders for adult pneumococcal vaccination. The Georgia Medical Practice Act does not specifically prohibit standing orders in inpatient settings. However, we were unable to find any other Georgia hospital using a standing order for inpatients, and our lawyers were not ready to permit one at our institution without clear provision in the Medical Practice Act. In states that do not have Medical Practice Acts authorizing standing orders for nurses in hospital settings, ACIP recommendations for standing-order programs can have little impact. Therefore, we suggest considering the substitution of provider-reminder systems as an interim solution while pursuing standing-order legislation for adult vaccines. While our results are comparable to some published standing-order programs, the high rate of physician noncompliance is a clear barrier and contributes to continuing missed opportunities. Even with this barrier, our protocol was measurably more successful than no protocol. Widespread implementation of standardized protocols for inpatient vaccination with influenza and pneumococcal vaccines could have positive impact for the health of the general adult population.

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